

Accessing and Understanding Consumer Awareness of and Potential Demand for Edamame

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Abstract. Two separate consumer-marketing studies were conducted between 30 Oct. and 2 Dec. 2002 to determine consumer awareness and potential demand for edamame [*Glycine max* (L.) Merrill]. The first study consisted of a sensory evaluation that included 113 participants who tasted and rated three edamame cultivars based on firmness and overall appeal and then ranked the beans in order of preference at The Pennsylvania State University, University Park Campus. To estimate demand, the participants answered questions regarding their likelihood to purchase edamame after the sensory evaluation. The second study, a telephone survey, was administered by a marketing firm to determine consumer awareness of edamame as well as their produce purchasing habits. Responses were collected from 401 consumers within the Metro-Philadelphia area. Consumer reaction to the sensory evaluation was positive, and after reading about the health benefits, a majority of consumers (92%) indicated they would likely purchase edamame and serve it in a meal whereas 89% gave this response after only sampling the edamame beans. When responses were compared among cultivars, overall liking for ‘Green Legend’ (6.29; 1 = extremely dislike; 9 = like extremely) was significantly lower than for ‘Kenko’ (6.84); however, neither cultivar was significantly different from ‘Early Hakucho’ (6.62). Participants also rated ‘Kenko’ as having a firmness that was ‘just about right’. Verbal comments from participants leaving the evaluation site included interest in purchasing edamame and inquiries as to where it could be purchased in the vicinity of the university. Telephone survey participants also expressed a willingness to purchase edamame and serve it in a meal after hearing about the potential health benefits (66%). Based on consumer responses to selected telephone survey questions, three distinct marketing segments were created. Potential purchasers (58% of participants), consisted of consumers who were more likely to consider the importance of the nutritional content of vegetables they purchased (73%), included the greatest percent of consumers who had purchased soy or soy-based products (70%), and were very likely (51%) and somewhat likely (46%) to eat edamame after learning about the health benefits. The second largest segment of participants characterized as unlikely edamame eaters (22% of participants) consisted of individuals who were very likely (20%) and somewhat likely (43%) to purchase vegetables they had never eaten before if evidence suggested that it might decrease the risk of cancer and/or other diseases. However, within this group, none of the participants were either very likely or somewhat likely to eat edamame after being told about the health benefits. The last group, characterized as requires convincing (20% of participants), consisted of individuals who were the least likely to base produce-purchasing decisions on the nutritional content of vegetables. After learning about health benefits specific to edamame, 8% of these participants were very likely and 48% were somewhat likely to eat edamame. Hence, separate marketing strategies may need to be developed to target these distinct segments based on interest in eating edamame, importance of nutritional information, and current vegetable purchasing habits.

Edamame (*Glycine max* [L.] Merrill), also known as edible or vegetable soybean, is an important Asian crop that is gaining popularity

in the United States. In Japan, for example, consumer demand for edamame is estimated at 145.1 million kilograms a year (Nguyen, 1997), and U.S. demand for edamame is projected to reach 13.5 million kilograms within the decade (Johnson, 2000). Edamame is particular cultivars of soybeans that are edible at an immature stage of growth (R6 stage, Rao et al., 2002). Edamame is high in protein, monounsaturated fatty acids (Johnson et al., 1999), isoflavones (Masuda, 1991), as well as calcium, phosphorus, iron, sodium, potassium, vitamin B1, vitamin B2, niacin, and ascorbic acid (Miles et al., 2000).

As it becomes more popular, defining con-

sumer preferences for edamame will become more important for growers and marketers as they seek to develop an effective marketing plan. Growers and marketers must understand potential consumers’ needs and concentrate on those defined characteristics in final products (Food Product Development, 1979). It would be most beneficial to have consumers included in product development to increase the probability of the competitiveness of the product in the marketplace especially since the success rate for new products to survive over one year is below 10% (Hollingsworth, 1996).

Consumer marketing techniques can be used to analyze demand as well as current and potential uses of edamame. Desirable sensory attributes can be determined for different edamame cultivars including appearance, flavor, aroma and texture characteristics. In addition, segmentation of select demographic variables can determine who might purchase edamame.

Currently, information on consumer perception and demand for edamame in the U.S. is limited. Johnson et al. (2000) reported that a distinction exists between U.S. and Japanese consumers regarding edamame texture and flavor. In a sensory evaluation involving a consumer panel, U.S. consumers preferred a buttery flavor and texture, in contrast to Japanese consumers who are known to prefer a flower-like and beany flavor and texture. Based on these results, growers for U.S. markets can select edamame cultivars and manipulate harvest to attain the preferred buttery taste and texture to meet consumer preference for edamame.

Two studies were conducted to investigate consumer perceptions and demand for edamame, based on taste. Other objectives of the study were to determine which edamame cultivars consumers might prefer and whether or not U.S. consumers were interested in potential edamame health benefits. Another objective was to better understand consumer produce purchasing habits.

Materials and Methods

Study 1: Sensory evaluation

A sensory evaluation was conducted at The Sensory Evaluation Laboratory at The Pennsylvania State Univ., University Park Campus, Pa., on 30 Oct. 2002 to determine which edamame (*Glycine max* [L.] Merrill) cultivars consumers preferred based on taste and bean firmness. Edamame used in the evaluation was grown at the Horticulture Research Farm, Russell E. Larson Research Center, Rock Springs, Pa (Sánchez et al., 2005). ‘Early Hakucho’ (Evergreen Seeds, Anaheim, Calif.), ‘Green Legend’ (Evergreen Seeds, Anaheim, Calif.) and ‘Kenko’ (Seedex, Inc., Buffalo, N.Y.) seed were inoculated with *Bradyrhizobium japonicum* and hand planted to a depth of 1.3 cm on 22 May 2002. Field plots were planted on 0.6 m wide raised beds in two staggered rows with 15.2 cm spacing within a row and between rows. Beds were spaced 1.5 m center to center for a seeding rate of about 42,242 seeds/ha. Nitrogen fertilizer

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was broadcast applied at a rate of 28.0 kg-ha⁻¹ before planting and six weeks after planting (Miles et al., 2000). Soil tests (Mehlich 3 test) indicated optimal amounts of phosphorus and potassium. Field plots were watered immediately after planting and on 25 and 29 May supplying each seed with 236.6 cm³ of water. Additionally, plants were sprinkler irrigated, supplying 2.5 cm of water on 18 July and 9 and 13 Aug. Weeds were managed by hand cultivation. Insect pests and diseases were not deemed to be a problem during the growing season. Plants were harvested on 14 to 28 Aug. 2002 when they reached the R6 stage (most pods were 80% to 90% filled and soluble solids, taken using a refractometer (Atago N-20e, Kirkland, Wash.), were between 8.5% and 12.0%; Johnson, 1999). Pods were stored in a -20 °C freezer until the day of the sensory evaluation. Throughout the evaluation period, 700 g of frozen edamame pods were placed in 7.57-L pots and boiled in 5 L of tap water with 7.5 g of salt for five minutes. Edamame was then shelled by hand and the beans were placed into individual, 56.7 g serving containers and capped and then kept on warming trays until distributed to participants.

In total, 113 participants were recruited from the university community, including students, staff and faculty, to taste the three edamame cultivars. All potential participants were screened and asked to participate if they ate green beans, lima beans or snap beans during meals or as a snack. This screener criterion was chosen as green beans have similar sensory characteristics to edamame, including taste and appearance. It was reasoned that if participants gave a positive response to the screener question, they were likely to evaluate the edamame cultivars without any predetermined biases toward other similar vegetables. Potential participants were asked to exclude themselves from the evaluation if they had an allergy to soy or soy-based products.

Participants received a 28.35 g sample of each of the three cultivars in random order. Based on acceptable in-field germination rates and marketable yields, obtained from a trial involving eight edamame cultivars (Sánchez et al., 2005), as well as a prescreening evaluation for taste and firmness that had been conducted at the university by the investigators and members of the Sensory Evaluation Laboratory. It took each participant about 15 min to complete the evaluation with five to seven minutes devoted to tasting and rating the three samples with the remainder of the time spent answering subsequent behavior, sociographic, and demographic questions.

After tasting each sample, participants rated each overall on a scale of 1 to 9 (1 = dislike extremely; 9 = like extremely), and then rated edamame bean firmness on a scale of 1 to 7 (1 = much too soft; 7 = much too firm). After tasting all three samples, participants ranked the beans in order of preference from "most liked" to "least liked." To understand current produce purchasing habits and the consumer's intention to purchase edamame after the evaluation, participants were also asked 12 additional questions, which included whether

they specifically purchased vegetables based on health claims and their likelihood of doing so in the future especially when considering an unfamiliar vegetable. Next, participants looked at a color photograph of edamame beans and read three descriptive segments that characterized edamame including 1) point of origin and use; 2) health benefits (Miles et al., 2000; Washam, 1996); and 3) how to prepare edamame for consumption. Based on this information and the color photograph, participants were asked whether they were familiar with edamame, had eaten or purchased it previously and their likelihood of eating edamame based on the descriptions provided for the product. Additional questions included if and how often participants purchased soy or soy-based products; what soy or soy-based products they purchased; and if they would purchase edamame from a store based on their tasting experience during the sensory evaluation. Participants answered seven demographic and two sociographic questions to aid in characterizing the survey population, e.g., gender, age, 2002 household income, education, number of adults and children in the household, ethnicity, if they were vegetarians, and if they were the primary food shoppers in the household. Upon completion of the sensory evaluation, each participant was given \$10.00 as compensation for their time.

Study 2: Telephone survey

To further understand which consumers would potentially purchase edamame and to develop a viable marketing strategy based on consumer segmentation, a telephone survey was administered in the Metro-Philadelphia area from 20 Nov. through 1 Dec. 2002. This metro area was selected because of its diverse representation of demographics including income, education and ethnicity (Sales and Marketing Management, 2001). The survey was conducted by TMR, Inc., a marketing firm located in Parsippany, N.J., which randomly contacted households within the metro area. This survey yielded a total of 401 completed responses. Participants answered screener questions used in the sensory evaluation and were asked to proceed with the survey if they had responded "yes" to eating green beans, lima beans, or snap beans during meals or as snacks and had no allergies to soy or soy-based products. Participants answered behavioral and demographic questions similar to those asked during the sensory evaluation. Based on responses from sensory evaluation participants, two additional questions were included to obtain even more consumer information

for the analysis: 1) if they were the primary person who prepared meals for the household, and 2) who in the household made decisions concerning the purchase of produce items. The average time needed to complete the survey was 7 min.

The Office of Research Protection at Pennsylvania State Univ. approved both surveys and the resulting interactions with the participants. For both surveys, data pertaining to consumer behavior and preference questions were analyzed with SPSS version 11.0 (Chicago, Ill.) using Pearson χ^2 statistic. Tukey's mean separation procedure ($\alpha = 0.05$), Friedman's analysis of rank ($\alpha = 0.05$) and Tukey's HSD procedure ($\alpha = 0.05$) were used to analyze overall liking, bean firmness, and cultivar rankings for edamame tested during the sensory evaluation using CompuSense five version 4.2 (Guelph, Ont., Canada).

Results

Study 1: Sensory evaluation

Consumer acceptance and overall liking of edamame fell into the "like slightly" and "like moderately" categories (a rating of 6 and 7, respectively, on a scale of 1 to 9). When responses were compared between cultivars, overall liking for 'Green Legend' (6.29) was significantly lower than for 'Kenko' (6.84; Table 1), however, neither cultivar was significantly different from 'Early Hakucho' (6.62). Mean scores for bean firmness of the three cultivars were in the "just about right" to "slightly too firm" range (a rating of 4 and 5, respectively, on a scale of 1 to 7), with 'Kenko' having a mean of 4.04 and 'Early Hakucho' and 'Green Legend' being significantly higher at 4.58 and 4.60, respectively (Table 1). These data indicate that participants considered the firmness of 'Kenko' just about right. Participants then ranked the edamame cultivars in order of preference with 'Green Legend' being the least preferred and significantly different than 'Kenko'. Although there were significant differences between 'Green Legend' and 'Kenko', neither cultivar was significantly different from 'Early Hakucho' (Table 2). After participants sampled and evaluated the edamame, the percent of participants who indicated they would still likely purchase edamame at a store and serve it in a meal continued to remain high at 89% (data not shown). Verbal comments from participants after the evaluation indicated that they were interested in knowing which retail outlets sold edamame in the vicinity of the university.

Responses were segmented based on

Table 1. Mean scores for consumer acceptance (overall liking) and firmness of three cultivars of cooked and shelled edamame beans tested during a sensory evaluation at the Penn State Univ. campus, University Park, Pa., on 30 Oct. 2002.

Cultivar	Overall liking ^a	Firmness ^b
'Early Hakucho'	6.62 ab ^x	4.58 a ^y
'Green Legend'	6.29 b	4.60 a
'Kenko'	6.84 a	4.04 b

^aBased on a 9-point hedonic scale with 9 = like extremely; 1 = extremely dislike

^bBased on a 7-point "just about right scale" with 7 = much too firm; 1 = much too soft.

^xMeans, within a column, followed by the same letter are not significantly different ($\alpha = 0.05$) using Tukey's mean separation procedure.

Table 2. Summary of consumer responses to questions regarding preference rankings between three cultivars of cooked and shelled edamame beans tested during a sensory evaluation at the Pennsylvania State University campus, University Park, on 30 Oct. 2002.

Cultivar	Rank sum ²
'Early Hakucho'	230 ab ¹
'Green Legend'	245 a
'Kenko'	203 b

¹The lower the rank sum, the more preferred the product.

²Means followed by the same letter are not significantly different using Friedman's analysis of rank and Tukey's HSD procedure ($\alpha = 0.05$).

selected demographic (e.g., participants 41 years and older vs. participants 40 years and younger) and sociographic (e.g., status as the primary food shopper) variables to determine

if one group yielded more positive responses to survey questions than their counterpart and was therefore more likely to become potential purchasers.

When participants were asked about their likelihood of purchasing edamame from stores after tasting it at the evaluation, more adults 41 years and older were very likely (66%) to purchase edamame from a store after tasting it in the evaluation than participants who were 40 years and younger (42%; Table 3). This segmentation was done to compare responses between participants who were members of the Baby Boom generation (born between 1946 and 1964) or other maturing generations, and responses from participants who were mainly members of either Gen X (born between 1965 and 1977) or the Millennial Generation (1994 to 1977; Mitchell; 2000). More participants

41 years and older were also very likely to purchase a vegetable they had never eaten before if evidence existed that indicated it might decrease the risk of cancer and/or other diseases (32%) than participants in the younger age group (12%). Significant differences were also apparent between the two groups for other survey questions. A greater percent of participants in the 41 and older age group (50%) were very likely to eat edamame after being told about the potential benefits than those in the 40 years and younger group (30%). When asked how often they ate Asian foods (Chinese, Japanese and/or Korean), 7% of participants 41 years of age and older reported that they did not eat these foods, whereas none of the participants in the 40 and younger age group stated that they did not eat these foods.

Comparisons based on 2002 household

Table 3. Effect of demographics and sociographics (e.g., gender, age, number of adults in the household, etc.) on participants' responses (%) to questions asked during an edamame sensory evaluation on 30 Oct 2003 at Pennsylvania State University, University Park.

Attribute	Gender		Age		Adults in household		Children in household		Education		Household income, 2002		Ethnicity		Vegetarian		Primary food shopper	
	Male	Female	≤40	≥41	1	≥2	0	≥1	High school diploma	Some college	≤\$39,999	≥\$40,000	Asian	Other	Yes	No	Yes	No
No. of participants	15	98	57	56	12	93	84	29	27	86	49	64	10	93	5	108	97	16
Percent	13	87	50	50	11	89	74	26	24	76	43	57	10	90	4	96	86	14
Specifically purchases vegetables based on claims that they may decrease the risk of cancer and/or other disease (%)	27	49 ^{NS}	39	54 ^{NS}	58	42 ^{NS}	45	48 ^{NS}	52	44 ^{NS}	39	52 ^{NS}	20	48 ^{NS}	20	47 ^{NS}	46	44 ^{NS}
Likelihood of purchasing a vegetable never eaten before if evidence existed that it may decrease the risk of cancer and/or other diseases (%)																		
Very likely	7	25 ^{NS}	12	32*	17	20 ^{NS}	21	24 ^{NS}	15	24 ^{NS}	14	28 ^{NS}	20	23 ^{NS}	20	22 ^{NS}	31	21 ^{NS}
Somewhat likely	53	55 ^{NS}	53	57 ^{NS}	75	53 ^{NS}	54	59 ^{NS}	71	49*	57	53 ^{NS}	40	58 ^{NS}	40	55 ^{NS}	44	57 ^{NS}
Neutral	33	15 ^{NS}	30	5*	8	20 ^{NS}	18	17 ^{NS}	7	21 ^{NS}	20	15 ^{NS}	40	15*	40	17 ^{NS}	25	16 ^{NS}
Somewhat unlikely	0	4 ^{NS}	3	4 ^{NS}	0	4 ^{NS}	5	0 ^{NS}	4	4 ^{NS}	6	2 ^{NS}	0	3 ^{NS}	0	4 ^{NS}	0	4 ^{NS}
Very unlikely	7	1 ^{NS}	2	2 ^{NS}	0	2 ^{NS}	2	0 ^{NS}	0	2 ^{NS}	2	2 ^{NS}	0	1 ^{NS}	0	2 ^{NS}	0	2 ^{NS}
Has purchased soy or soy-based products (%)	47	62 ^{NS}	58	63 ^{NS}	75	56 ^{NS}	61	59 ^{NS}	44	64 ^{NS}	59	61 ^{NS}	100	56*	100	58*	59	67 ^{NS}
More than once a week	0	5 ^{NS}	3	6 ^{NS}	0	4 ^{NS}	4	6 ^{NS}	0	5 ^{NS}	3	5 ^{NS}	10	4 ^{NS}	0	5 ^{NS}	5	0 ^{NS}
About once a week	28	13 ^{NS}	15	14 ^{NS}	11	15 ^{NS}	18	6 ^{NS}	17	14 ^{NS}	17	13 ^{NS}	10	14 ^{NS}	60	11*	16	9 ^{NS}
Two to three times a month	29	21 ^{NS}	24	20 ^{NS}	11	25 ^{NS}	27	6 ^{NS}	25	21 ^{NS}	17	26 ^{NS}	20	21 ^{NS}	20	22 ^{NS}	21	27 ^{NS}
About once a month	29	16 ^{NS}	27	9*	22	19 ^{NS}	14	29 ^{NS}	17	18 ^{NS}	24	13 ^{NS}	60	11*	20	18 ^{NS}	18	18 ^{NS}
A few times a year	14	44 ^{NS}	30	51 ^{NS}	56	37 ^{NS}	37	53 ^{NS}	41	41 ^{NS}	38	43 ^{NS}	0	50*	0	44 ^{NS}	40	46 ^{NS}
Was familiar with or had heard of edamame (%)	13	17 ^{NS}	16	18 ^{NS}	17	15 ^{NS}	19	10 ^{NS}	7	20 ^{NS}	14	19 ^{NS}	40	14 ^{NS}	0	18 ^{NS}	19	6 ^{NS}
Has eaten edamame before (%)	7	13 ^{NS}	11	14 ^{NS}	17	11 ^{NS}	14	7 ^{NS}	7	14 ^{NS}	12	13 ^{NS}	40	9 ^{NS}	0	13 ^{NS}	13	6 ^{NS}
Has purchased edamame from a store (%)	0	6 ^{NS}	4	7 ^{NS}	8	4 ^{NS}	6	3 ^{NS}	4	6 ^{NS}	6	5 ^{NS}	20	4 ^{NS}	0	6 ^{NS}	6	0 ^{NS}
How likely to eat edamame after being told about the benefits (%)																		
Very likely	26	42 ^{NS}	30	50*	42	39 ^{NS}	52	36 ^{NS}	33	42 ^{NS}	27	50*	40	41 ^{NS}	40	39 ^{NS}	39	44 ^{NS}
Somewhat likely	67	50 ^{NS}	58	46 ^{NS}	58	52 ^{NS}	45	55 ^{NS}	63	49 ^{NS}	59	47 ^{NS}	60	51 ^{NS}	60	52 ^{NS}	53	50 ^{NS}
Neutral	7	6 ^{NS}	9	4 ^{NS}	0	7 ^{NS}	3	7 ^{NS}	4	7 ^{NS}	10	3 ^{NS}	0	7 ^{NS}	0	7 ^{NS}	6	6 ^{NS}
Somewhat unlikely	0	1 ^{NS}	2	0 ^{NS}	0	1 ^{NS}	0	1 ^{NS}	0	1 ^{NS}	2	0 ^{NS}	0	1 ^{NS}	0	1 ^{NS}	1	0 ^{NS}
Very unlikely	0	1 ^{NS}	2	0 ^{NS}	0	1 ^{NS}	0	1 ^{NS}	0	1 ^{NS}	2	0 ^{NS}	0	0 ^{NS}	0	1 ^{NS}	1	0 ^{NS}
How likely to purchase edamame from a store after tasting it at the evaluation (%)																		
Very likely	47	55 ^{NS}	42	66*	75	50 ^{NS}	51	62 ^{NS}	52	55 ^{NS}	43	62*	50	57 ^{NS}	60	54 ^{NS}	51	75 ^{NS}
Somewhat likely	33	36 ^{NS}	42	29 ^{NS}	25	37 ^{NS}	36	35 ^{NS}	44	32 ^{NS}	43	30 ^{NS}	30	34 ^{NS}	40	35 ^{NS}	39	13*
Neutral	7	8 ^{NS}	11	5 ^{NS}	0	10 ^{NS}	11	0 ^{NS}	4	9 ^{NS}	10	6 ^{NS}	20	7 ^{NS}	0	8 ^{NS}	7	12 ^{NS}
Somewhat unlikely	13	1*	5	0 ^{NS}	0	3 ^{NS}	2	3 ^{NS}	0	4 ^{NS}	4	2 ^{NS}	0	2 ^{NS}	0	3 ^{NS}	3	0 ^{NS}
Very unlikely	0	0 ^{NS}	0	0 ^{NS}	0	0 ^{NS}	0	0 ^{NS}	0	0 ^{NS}	0	0 ^{NS}	0	0 ^{NS}	0	0 ^{NS}	0	0 ^{NS}
How often Chinese, Japanese, and/or Korean foods are eaten (%)																		
More than once a week	13	4 ^{NS}	9	2 ^{NS}	0	5 ^{NS}	6	3 ^{NS}	4	6 ^{NS}	8	3 ^{NS}	40	2*	0	6 ^{NS}	6	0 ^{NS}
About once a week	20	10 ^{NS}	12	11 ^{NS}	8	10 ^{NS}	10	17 ^{NS}	7	13 ^{NS}	12	11 ^{NS}	40	10*	20	11 ^{NS}	11	13 ^{NS}
Two to three times a month	13	31 ^{NS}	33	23 ^{NS}	67	26*	28	28 ^{NS}	19	31 ^{NS}	29	28 ^{NS}	10	29 ^{NS}	40	28 ^{NS}	28	31 ^{NS}
About once a month	33	29 ^{NS}	23	36 ^{NS}	8	34 ^{NS}	30	28 ^{NS}	37	27 ^{NS}	27	31 ^{NS}	10	31 ^{NS}	40	30 ^{NS}	29	31 ^{NS}
A few times a year	20	22 ^{NS}	23	21 ^{NS}	17	22 ^{NS}	21	24 ^{NS}	22	22 ^{NS}	22	22 ^{NS}	0	24 ^{NS}	0	21 ^{NS}	23	19 ^{NS}
Does not eat these foods	0	4 ^{NS}	0	7*	0	3 ^{NS}	5	0 ^{NS}	11	1*	2	5 ^{NS}	0	4 ^{NS}	0	4 ^{NS}	3	6 ^{NS}
Cultivar preference (%)																		
'Early Hakucho'	20	33 ^{NS}	35	27 ^{NS}	25	34 ^{NS}	31	31 ^{NS}	30	31 ^{NS}	29	33 ^{NS}	30	30 ^{NS}	20	32 ^{NS}	34	13 ^{NS}
'Green Legend'	27	22 ^{NS}	18	29 ^{NS}	17	23 ^{NS}	23	24 ^{NS}	29	21 ^{NS}	14	30 ^{NS}	20	22 ^{NS}	40	22 ^{NS}	24	19 ^{NS}
'Kenko'	53	45 ^{NS}	47	44 ^{NS}	58	43 ^{NS}	46	45 ^{NS}	41	48 ^{NS}	57	37*	50	48 ^{NS}	40	46 ^{NS}	42	68*

^{NS}, Nonsignificant or significantly different at $P \leq 0.05$ within categories (Gender, education, etc.) based on Pearson χ^2 statistic.

income yielded differences for those very likely to eat edamame after being informed about the potential benefits, with more higher-income individuals (incomes of or greater than \$40,000) choosing this response (50% vs. 27% for those with an income at or less than \$39,999; Table 4). More participants with the higher income were also very likely to purchase edamame from a store after tasting it at the evaluation (62%) compared to those individuals in the lower income group (43%).

Since edamame is an important crop in Asian countries, participant responses were also analyzed based on reported ethnicity. Differences

were apparent for frequency of purchasing soy or soy-based products. More participants of Asian descent purchased soy or soy-based products in general and more of them purchased them about once a month (60%) than other participants (11%). Compared to non-Asian participants, none of these participants reported that they purchased these products a few times a year. More participants of Asian descent ate Chinese, Japanese and/or Korean foods more than once a week (40%) and about once a week (40%) compared to participants who reported other ethnicities (2% and 10%, respectively).

More participants who were the primary

food shopper reported that they were somewhat likely to purchase edamame from a store after tasting it at the sensory evaluation (39%) compared to participants who were not the primary food shopper (13%). When cultivar preference was analyzed based on segmentation, participants who responded that they were not the primary food shopper (68%) chose 'Kenko' as their preferred cultivar as opposed to their counterparts (42%; Table 3).

Study 2: Telephone survey

The object of the cluster analysis (SPSS, Inc., 2001) was to determine whether meaning-

Table 4. Description of three consumer segments derived from cluster analysis based on participants' responses (%) to questions about produce purchases, edamame attributes and demographic and sociographic questions during a telephone survey conducted in the Metro-Philadelphia area, Pa., from 20 Nov. through 2 Dec. 2002.

Variable	Potential purchasers	Unlikely edamame eaters	Requires convincing	Significance ^a
Number of participants (no.)	234	89	78	
Percent of participants (%)	58	22	20	
Purchases and eats vegetables based on their nutritional content (%)	73	69	47	1,3*
Specifically purchases vegetables based on claims that they may decrease the risk of cancer and/or other disease (%)	54	30	26	4*
How likely to purchase a vegetable never eaten before if evidence that it may decrease the risk of cancer and/or other diseases (%):				
Very likely	53	20	0	4*
Somewhat likely	38	43	0	4*
Neutral	9	32	30	4*
Somewhat unlikely	0	5	30	1,3*
Very unlikely	0	0	40	4*
Has purchased soy or soy-based products (%):	70	35	44	4*
More than once a week	12	5	3	1*
About once a week	16	11	19	NS
Two to three times a month	23	11	5	1,3*
About once a month	13	19	16	NS
A few times a year	36	54	57	1*
Was familiar with or had heard of edamame (%)	15	3	8	1,2*
Has eaten edamame before (%)	11	2	4	NS
Purchased edamame from a store (%):	8	2	3	NS
How likely to eat edamame after being told about the benefits (%):				
Very likely	51	0	8	4*
Somewhat likely	46	0	48	4*
Neutral	3	49	21	1,2*
Somewhat unlikely	0	22	7	1,2*
Very unlikely	0	29	16	4*
How often Chinese, Japanese, and/or Korean foods are eaten (%):				
More than once a week	8	6	3	NS
About once a week	14	12	21	NS
Two to three times a month	29	14	33	2*
About once a month	25	27	23	NS
A few times a year	18	21	10	NS
Does not eat these foods	6	20	10	1,2*
Is the primary food shopper for the household (%)	79	73	62	1,3*
Is the primary person who prepared meals for the household (%)	78	70	68	1*
Is the primary person who makes decisions concerning produce items purchased for the household (%)	80	72	61	1,3*
Spouse/significant other makes decision concerning produce items purchased for the household (%)	15	23	24	1*
Child/children makes decision concerning produce items purchased for the household (%)	0	2	3	1*
Other family member makes decision concerning produce items purchased for the household (%)	5	3	12	3*
Female participants (%)	72	62	59	NS
Age 41 and older (%)	52	52	47	NS
Single adult households (%)	22	26	24	NS
Households with no children (%)	57	62	64	NS
At least some college education (%)	74	66	59	1,3*
2002 household income >\$50,000 (%)	57	53	53	NS
Asian decent (%)	3	2	3	NS
Vegetarian (%)	5	3	7	NS

^a1 = cluster 2 and 3 combined and tested against 1; 2 = cluster 1 and 3 combined and tested against 2; 3 = cluster 1 and 2 combined and tested against 3; 4 = all cluster comparisons are significantly different.

NS,*Non-significant or significantly different at $P \leq 0.05$ as based on Pearson χ^2 statistic.

ful customer segmentations, based on participants' answers to several questions, could be created. Producers or retailers could ideally target favorable segments based on responses to questions regarding interest in and demand for edamame. Cluster analysis has been used by researchers to define consumer segments as to their preference for horticultural products such as edible flowers (Kelley et al., 2001), perceived consumer plant knowledge (Hardy et al., 1999), and industry use and understanding of integrated pest management practices (Sellmer et al., 2003). Variables used for clustering were based on produce-purchasing habits and attitudes about edamame. By using K means, the three-cluster solution was selected to develop the consumer market segments: Potential Purchasers, Unlikely Edamame Eaters, and Requires Convincing.

Segment 1. The largest segment, potential purchasers, consisted of 234 participants (58%). These participants appeared to be more concerned about the nutritional content of the produce they purchased than the other two segments, Unlikely Edamame Eaters and Requires Convincing. Potential Purchasers were more likely to have purchased and eaten vegetables based on their nutritional content (73%) and also specifically purchased vegetables based on reports that eating the vegetable might decrease the risk of cancer and/or other diseases (54%; Table 4). A greater number of Potential Purchasers were very likely to purchase a vegetable never eaten before if evidence existed that it might decrease the risk of cancer and/or other diseases (54%), than Unlikely Edamame Eaters and Requires Convincing. Potential Purchasers also consisted of the greatest number of participants who had purchased soy or soy-based products in the past (70%; Table 4).

Favorably, Potential Purchasers was the segment that contained the greatest percent of consumers (15%) that were familiar with or had heard of edamame before the telephone survey (Table 4). No statistical differences, however, were found among the three segments in regards to the percent of participants who had eaten edamame before.

After survey participants were informed about where edamame had originated, the health benefits and its preparation and uses, all of the Potential Purchasers were neutral (3%), somewhat likely (46%) or very likely (51%) to eat edamame (Table 4).

With regard to the frequency of eating Chinese, Japanese, and/or Korean foods, there were few significant differences between segments. Although Potential Purchasers were equally as likely to eat these foods during the course of a year as Unlikely Edamame Eaters and Requires Convincing, fewer of the Potential Purchasers responded that they did not eat these foods (6%).

Most participants in this segment were the primary food shoppers (79%), those who prepared meals for the household (78%), and also the primary persons who made decisions concerning produce items purchased for the household (80%).

Statistical differences regarding demographics and sociographics were nonexistent

except when comparisons were made based on the percent of participants in each segment who had attained at least some level of college education. Potential Purchasers consisted of the greatest percent of individuals with at least some college education (74%).

Segment 2. The second segment, Unlikely Edamame Eaters, consisted of 89 of the telephone survey participants (22% of participants). Participants in this segment (30%) were less likely than Potential Purchasers (54%) to specifically purchase vegetables based on claims that they might decrease the risk of cancer and/or other diseases (Table 4). Over half of these participants, however, responded that they would be likely (combination of "somewhat likely" and "likely") to purchase a vegetable they never had eaten before if evidence existed that it might decrease the risk of cancer and/or other diseases. Of Unlikely Edamame Eaters, 43% were somewhat likely to do so, a greater percent than the other two segments. Consumers who were identified as Unlikely Edamame Eaters consisted of the fewest number of telephone survey participants who had purchased soy or soy-based products in the past (35%), compared to the two other segments.

When asked how likely they would be to eat edamame after being told about the health benefits of the product, a conflict was apparent between their answers to this question and their responses to the question regarding how likely they would be to purchase vegetables based on evidence that it might decrease the risk of cancer and/or other diseases. Though over half, as reported above, would likely purchase vegetables based on health benefits, none of the participants in this segment were either somewhat likely or very likely to eat edamame based on reading about its potential benefits. When compared to the other two segments, Unlikely Edamame Eaters contained the largest percent of individuals who would be neutral, somewhat unlikely, and very unlikely to do so, (49%, 22%, and 29%, respectively).

Few significant differences occurred within the distribution as to how often these three segments ate Chinese, Japanese and/or Korean foods. Significance did exist, however, with 20% of Unlikely Edamame Eaters stating they did not eat these foods, the highest percent of all three segments.

Segment 3. The last segment, Requires Convincing, consisted of 78 of the survey participants (20% of participants). Individuals characterized as Requires Convincing were unlikely to take nutritional content and health benefits into consideration in their purchasing decisions. Less than half of these participants purchased and consumed vegetables based on their nutritional content (47%) and specifically purchased vegetables based on claims that they might decrease the risk of cancer and/or other diseases (26%). In fact, none of these participants were either very likely or somewhat likely to purchase a vegetable never eaten before even if evidence existed that it might decrease the risk of cancer and/or other diseases. Thirty percent of Requires Convincing were neutral on the subject, while 30% were somewhat unlikely, and 40% were very unlikely.

These participants were more likely to have purchased soy or soy-based products (44%) and were more inclined to be very likely (8%) and somewhat likely (48%) to eat edamame after being told about the benefits than Unlikely Edamame Eaters. Requires Convincing also had the lowest percent of participants who were the primary food shoppers (62%) and who made decisions concerning produce items that were purchased for the household (61%).

Comparison of Participant Responses to Common Survey Questions

Sensory evaluation participants shared few similarities with telephone survey participants based on demographics and sociographics. Compared to telephone survey participants, sensory evaluation participants were more likely to be female (87% vs. 67%), however, less likely to be 41 years of age and older (50% vs. 67%), live in single adult households (11% vs. 23%), and live in a household without children (74% vs. 59%; Table 5). A greater number of sensory evaluation participants indicated that they were of Asian descent (10%) and were more likely to be the primary food shopper (86%) than the telephone survey participants (3% and 74%, respectively). Participants from both surveys were equal in having acquired at least some college education (76% sensory evaluation participants vs. 70% telephone survey participants), and were vegetarians (4% vs. 5%).

A greater percent of sensory evaluation participants was likely to purchase a vegetable they had never eaten before if evidence existed that it might decrease the risk of cancer and/or other diseases (77%) compared to telephone survey participants (67%). More sensory evaluation participants were also likely to eat edamame after they were told about the health benefits (92%) compared to telephone survey participants (66%). Of the sensory evaluation participants, 60% had purchased soy or soy-based products before the evaluation, while 57% of telephone survey participants had also purchased such products including soy "meat" products (burgers and chicken), "dairy" (soy milk, yogurt, ice cream, and cheese), roasted soy nuts, soy protein powders for drinks, and tofu. In total, 41% of the sensory evaluation participants and 26% of the telephone survey participants purchased these products a few times a year, with 19% of the sensory evaluation participants and 16% of the telephone survey participants purchasing these products at least once a week (data not shown).

Participants were also asked how often they ate Asian foods including Chinese, Japanese and/or Korean foods. Of both samples, at least 73% consumed these foods at least once a month.

There were no differences between the percentage of participants in both surveys who 1) specifically purchased vegetables based on claims that eating them might decrease the risk of cancer and/or other diseases (46% sensory evaluation participants vs. 43% telephone survey participants); 2) were familiar with or had heard of edamame before (17% vs. 11%);

Table 5. Comparison of responses to questions about produce purchases, edamame attributes and demographic and sociographic questions for consumers who participated in a sensory evaluation at the Pennsylvania State University campus, University Park, on 30 Oct. 2002 and in a telephone survey in the Metro-Philadelphia area, Pa., from 20 Nov. through 2 Dec. 2002.

Attribute	Sensory evaluation participants	Telephone survey participants
Number of participants	113	401
Specifically purchases vegetables based on claims that they may decrease the risk of cancer and/or other disease (%)	46	43 ^{NS}
Likely to purchase a vegetable never eaten before if evidence that it may decrease the risk of cancer and/or other diseases (%)	77	67*
Has purchased soy or soy-based products (%)	60	57 ^{NS}
Was familiar with or had heard of edamame (%)	17	11 ^{NS}
Would likely eat edamame after told about the benefits (%)	92	66*
Has eaten edamame before (%)	12	8 ^{NS}
Has purchased edamame from a store (%)	5	6 ^{NS}
Eats Chinese, Japanese and/or Korean foods once a month (%)	74	73 ^{NS}
Female participants (%)	87	67*
Age 41 and older (%)	50	67*
Single adult households (%)	11	23*
Households with no children (%)	74	59*
Some college education (%)	76	70 ^{NS}
Asian decent (%)	10	3*
Vegetarian (%)	4	5 ^{NS}
Primary food shopper (%)	86	74*

^{NS}, Nonsignificant or significantly different at $P \leq 0.05$ between groups (telephone survey participants vs. sensory evaluation participants) based on on Pearson χ^2 statistic.

3) had eaten edamame before (12% vs. 8%); and, 4) had purchased edamame before (5% vs. 6%; Table 5).

Discussion

Based on sensory characteristics, 'Kenko' appears to be the most appealing of the cultivars tested, though 'Early Hakucho' could be a substitute since only one significant difference existed between the two. 'Green Legend', however, was significantly less desirable than 'Kenko' for each rating/ranking. 'Kenko' received a higher overall liking score, lower mean firmness score, and was ranked higher in the order of preference than 'Green Legend'. If all three cultivars were available for consumer purchase, it may be best to exclude 'Green Legend' and use either 'Kenko' or 'Green Legend' in the final product offering. If a decision needed to be made between 'Early Hakucho' and 'Green Legend', either cultivar could suffice since there were no significant differences between the two.

Although significant differences were apparent when comparing demographics and sociographics for sensory evaluation participants, few unexpected differences resulted from the analysis. Differences that occurred based on a participant's age could help direct marketing efforts. More of the participants 41 years of age and older were very likely to purchase a vegetable they had never eaten before based on health benefits and would purchase edamame after being told about its benefits. This group is of importance as it includes members of the largest demographic segment and is known as the Baby Boomers. Marketers target this group of influential individuals due to segment size and spending power (Potter, 2003). Efforts to cultivate interest in edamame could prove valuable to growers and marketers because of these factors.

If marketers or producers were interested

in targeting other demographic groups with favorable responses, focusing on consumers with an income of \$40,000 or greater could also be appealing. Over half of the individuals in this group were very likely to eat edamame after being informed about its potential benefits (point of origin, use, health benefits and how to prepare edamame for consumption) and purchase edamame after tasting it. Based on this data, promotional materials describing the tastes and benefits of edamame could be created and mailed or delivered to neighborhoods or regions where participants with this level of income reside.

Few essential differences were apparent between those who were the primary food shopper and their counterparts. Significant and positive responses collected from the primary food shopper would be of great value as these consumers could choose to either include or exclude a particular food item from their grocery list. This group can also act as a gatekeeper regarding the produce and products served at family meals. Though not significantly different, more than half of both the primary food shoppers and their counterparts had purchased soy or soy-based products and would be very likely to purchase edamame from a store after tasting it at the evaluation. Efforts should continue to pursue primary food shoppers as they control not only what is purchased for their personal consumption, but also that of their families, and in some cases, extended families.

Instead of choosing a mass marketing strategy, a marketing strategy could focus on clusters developed from telephone survey responses. A marketing plan could be based on responses from consumers who appear to have an interest in edamame and would tend to purchase it. This situation may be more successful and less costly than a strategy that targets all possible consumers. When deciding on which segment to target first, the

most significant segment would be Potential Purchasers. Clearly, this segment is aware of the health benefits associated with eating vegetables in general, and therefore may be the most responsive to advertising and promotions aimed at informing them about the potential health benefits of edamame.

Introducing edamame into a Potential Purchasers diet may simply be the result of advertising it as an ingredient in Asian cuisine or as an additional a soy product. With 94% of participants in this segment already eating ethnic foods such as Chinese, Japanese, and/or Korean at least a few times a year, it is quite possible to familiarize this audience with edamame, first by using it as a food ingredient in similar ethnic cuisine. Edamame could even be used as a featured item of the month at Asian restaurants, supermarkets, and ethnic food markets. Including recipes on containers and placing edamame in grocery stores next to complementary Asian foods, currently one of the most popular ethnic cuisines for U.S. consumers (Macey, 2001), is another method to promote it. Restaurant usage could also help make consumers aware of the taste and texture of edamame especially since consumers continue to spend 50% of their food dollar frequenting restaurants (Stys, 2003).

Potential Purchasers also purchase soy and soy-based products; therefore, they may be more interested and more willing to purchase edamame, than other segments. An important aspect to investigate is whether Potential Purchasers would choose to purchase soy products based on nutritional content, taste, or both. To gain market share, a product's favorable taste is crucial to entice consumers to become repeat purchasers (Egan, 2001). With more than one product attribute of potential interest, promotional strategies can be developed to meet the needs of a wide audience of consumers, ranging from those who primarily value flavor to those who primarily value nutritional content. With 89% of sensory evaluation participants reporting that they would purchase edamame and serve it in a meal, it is promising that a strategy aimed at promoting flavor and nutritional benefits of soy and soy-based products could also include edamame.

It is also apparent that Potential Purchasers also have an interest in the nutritional content of produce, edamame's health benefits, and would potentially purchase edamame at a retail outlet. Labeling information should be created to inform consumers who may be unfamiliar or have less experience with such products about their nutritional benefits, preparation, and usage.

Fewer positive responses regarding produce purchases and interest in edamame existed for the other two segments. A combined 63% of Unlikely Edamame Eaters were either very likely or somewhat likely to purchase a vegetable they never had eaten before if evidence existed that it might decrease the risk of cancer and/or other diseases. However, since none of these participants would be likely to eat edamame after being told of its potential benefits, promotions that focus on product characteristics other than recognized health benefits would be needed.

If the reason for not purchasing a product is based on a preconceived negative opinion regarding taste, efforts such as providing samples could give these consumers the opportunity to try the product without a monetary risk. Recipe suggestions as well as cooking demonstrations may help these consumers learn about how they can use edamame in their food preparation. Since this segment consisted of the greatest number of participants who did not eat ethnic foods, such as Chinese, Japanese, and/or Korean, mainstream recipes and samples from cooking demonstrations could be used to convince consumers that not all edamame food applications need to be Asian. In-store sampling is an effective method for acquainting consumers with products and their tastes and can dramatically increase sales of products during the sampling period (Mills, 1998).

Those participants characterized as Requires Convincing appear to be interested in edamame, based on specific health benefits, origin, cooking preparation and some examples of how edamame is eaten. For vegetables in general, however, health benefits would not completely convince this segment to purchase such items. Perhaps by including edamame information such as origin, cooking preparation and some examples of how it is eaten, these consumers would better understand edamame.

Conclusion

Based on results from both surveys, the introduction of edamame into the consumer's diet has the potential to be a successful venture. Over half of the participants in both survey groups (92% sensory evaluation and 66% of telephone survey participants) would likely eat edamame after being informed about the potential health benefits, origin, preparation and uses. It is possible that the significant

difference between the two groups occurred because sensory evaluation participants not only read about edamame's characteristics, but also had an opportunity to view a photograph of edamame beans before tasting. Therefore, it may be beneficial to include both pieces, written and visual descriptions, on packages for sale in retail outlets. Clearly, a majority of participants in both surveys found some value when reading about edamame characteristics and if a more desirable cultivar is used, such as 'Kenko'; an attractive retail combination could be created.

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